"Hydrothermally modified agricultural detritus into zeolitic materials with and without electrolyte media: Potential sorbents for uptake of metal ions"

Introduction

Recently the definition of pollution is describes as "Pollution is not a contingent process but it is the total effect of interaction and chemical reaction of waste matter and newly introduced hazardous toxic substances to the components of environment".

Different inorganic and organic water pollutants generally present in the wastewater, out of these the heavy metals – an inorganic pollutant are considered as priority class of pollutants. Their presence even in very low concentration (ppm or ppb level) can be an obstacle to the use of water and industrial effluents [1].

Literature survey

Heavymetals are elements having atomicweights between 63.5 and 200.6, and a specific gravity greater than 5.0 [2]. With the rapid development of industries such as metal plating facilities, mining operations, fertilizer industries, tanneries, batteries, paper industries and pesticides, etc., heavy metals wastewaters are directly or indirectly discharged into the environment increasingly, especially in developing countries. Unlike organic contaminants, heavy metals are not biodegradable and tend to accumulate in living organisms and many heavy metal ions are known to be toxic or carcinogenic. Toxic heavy metals of particular concern in treatment of industrial wastewaters include zinc, copper, nickel, mercury, cadmium, lead and chromium.

Heavymetal ions have lethal effects on all forms of life and these enter the food chain through the disposal of wastes in water channels. From among various metal ions, lead, cadmium, copper, nickel, and chromium(VI) are at the top on the toxicity list [3]. Due to non-biodegradability, metal ions accumulate and their amounts are increased along the food chain. Hence, their toxic effects are more pronounced in the animals at higher trophic levels.

Among the several currently known physical, chemical and biological methods which are in use for wastewater treatment, adsorption still continues to be most widely used process. The adsorption by activated carbon, has become the water industry's standard for the reclamation of municipal and industrial wastewater to a potable quality [4]. The material most used as adsorbent is activated carbon (AC) [5-7]. However, the cost of activated carbon

is high; its regeneration also requires additional expense. So, researchers in science and engineering have increased interest in finding low-cost adsorbents such as industrial sludge waste, bagasse fly ash (BFA), biomass, husk, slag, carbon slurry, etc. to remove inorganic and organic pollutants from wastewater [8,9]. There are many reports available for the sorption of heavy metals by BFA [10,11], but the conversion of BFA in to zeolitic materials using chemically modified treatment gives the higher capacity than the native BFA.

Zeolites are hydrated aluminosilicates of the alkaline and alkaline earth metals. The zeolite framework contains opened cavities in the form of channels and cages. The channels are large enough to allow the passage of guest species**.**

Objective of the work

The aim of the present work is to develop potential low cost adsorbents for the removal of metals by using agricultural detritus Bagasse fly ash (BFA), a solid waste of sugar industries. The BFA is successfully converted into zeolites by alkaline hydrothermal treatment with and without electrolyte media. The adsorbents known as electrolyte treated conventional zeolitic bagasse fly ash (ECZBFA, with electrolyte media) and conventional zeolitic bagasse fly ash (CZBFA, without electrolyte media) materials. The batch and column studies were carried out to examine sorption of metals ions (Pb^{+2}, Cd^{+2}, Cu^{+2}, Ni^{+2} and Cr^{+6}) on BFA, CZBFA and ECZBFA. The kinetics and equilibrium isotherms of metals were studied which enable the adsorption system to be modeled. Desorption studies have been carried out with HCl, HNO_3 and EDTA as desorbing agents. The operational parameters observed in these investigations give an idea to design a simpler sorption system for metal ions from wastewater. If applied on large scale the sorption data can be useful for the elimination of metals from wastewater by above sorbents.

The thesis is divided into six chapters

The aim of this work is to synthesize the potential cost effective adsorbent and their utilization for the removal of metals (Pb^{+2}, Cd^{+2}, Cu^{+2}, Ni^{+2} and Cr^{+6}) from aqueous solution by using BFA, CZBFA and ECZBFA.

Chapter-1: Introduction and Literature Review

This chapter covers the useful information on the scenario of water pollution including permissible limits of metals in different areas. Literature studies on the types of pollutants, their effect on living beings, and their ways to the water system. Current

references along with the previous studies on the available technologies as well as sorbents for the removal of pollutants from water and wastewater have been reported. It contains brief objective and scope of the present work.

Chapter-2: Materials and Methods

This chapter comprises the materials and experimental methods used during the whole research work. The BFA is successfully converted into zeolites by alkaline hydrothermal treatment with and without electrolyte media.

Chapter-3: Instrumental Analysis

This chapter deals with the characterization of the sorbents BFA, CZBFA and ECZBFA by different instrumental techniques like FTIR, BET, PXRD, XRF, and SEM as well as classical methods has been explained.

Chapter-4: Thermal Analysis

The chapter describes the thermal analysis of the sorbents. The Coats and Redfern method was used to evaluate the kinetic parameters from Thermo gravimetric curves.

Chapter-5: Results and Discussion

The native BFA and synthesized zeolitic materials was used as sorbents for uptake of metals ions. The various operating variables, viz., solution pH, contact time, initial phenol concentration, adsorbent dose and temperature. The sorption isotherms and kinetics studies were involved in details. The thermodynamic parameters are also carried out using temperature studies to know the nature of sorption.

Chapter-6: Column dynamics

This chapter describes the utilization of BFA and synthesized zeolitic materials as a fixed bed column for the removal of metals ions as pilot study for industrial application. It includes breakthrough curves of metals removal to evaluate the fixed bed column capacities of the sorbents. It also includes the desorption studies of sorbed metals with different eluents.

Conclusion:

The results and discussion is followed by the concluding remarks derived from this research work.

References:

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